Open Access
J. Glob. Innov. Agric. Sci., 2023, 11(4):657-664
ISSN (Online): 2788-4546; ISSN (Print):2788-4538
DOI: https://doi.org/10.22194/JGIAS/23.1129
http://www.jgiass.com

Society for Innovative Agiculture

The yield performance of maize (*Zea mays* L.) genotypes under different planting times

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Adoption of graded and certified seeds for planting has a high demand among the farmers at Kirkuk city, where maize has different way of consumption like a staple food, forge crop and raw material for industry. This study aimed to evaluate common domestic maize genotype, against the modern maize genotype under different summer planting times at the district of Kirkuk - Kirkuk governorate, Iraq. The study include two genotypes of maize, (Bohoth106 modern genotype and domestic maize genotype) and three planting times (early-July, mid-July and late-July). The experiment was established in three replicate blocks under randomized complete block design. The results showed that Bohoth106 which planted at mid-July had a significant performance, in traits kernels weight per ear (164.5 g), grain yield (11.2 t.ha^{-1}), Stover yield (25.1 t.ha^{-1}) and biomass yield (36.2 t.ha^{-1}). Whereas, the lowest values were observed in the interaction between domestic maize with early-July planting time. Simple correlation coefficients revealed that grain yield positively and significantly correlated with leaf area index, Stover yield, biomass yield, grain Stover ratio and harvest index. According to the presented results farmers can cultivate Bohoth106 at mid-July till late-July to achieve high grain yield during summer planting time in Kirkuk district, Iraq.
Keywords: Maize yield, Genotypes, Planting times, Regression relationship.

INTRODUCTION

Maize (*Zea mays* L.) considered the most important cereals after wheat and barley in terms of cultivated area and grain production also it is measured one of the strategic crops in Iraq (AL-Dawdi and AL-Jobouri, 2015). Maize grain production in Iraq reached 209 thousand tons in 2018 and imported maize was 308.3 thousand tons (FAO, 2020). However, maize production in Iraq increased to double in 2020 to 419.3 thousand tons where the grain yield average reached 4.1 t.ha^{-1} (CSO, 2021). Kirkuk governorate occupied the first place among the Iraq's governorates in cultivated area (23.711 hectare), grain production (1.746.48 ton) and in average yield was (7.366 t.ha^{-1}) in 2020 (CSO, 2021). Mainly maize grains are using for human consumption, livestock forage and poultry feeding. However, in Iraq maize production per unit area still suffering due to the lack in crop management practices like planting time, genotype selection and others. This shortage in maize production needs recalculation for all possible techniques to increase the yield by using modern methods in agricultural practices such as selecting an appropriate genotype with optimum planting time (Hussein and Ahmed, 2023). Cultivating recommended genotype by the geneticists which can produce high yield could be one of the solutions to improve maize production (AL-Niemi, *et al.*, 2014; Hasan *et al.*, 2018).
Selecting an appropriate maize genotype for cultivation considered as a key factor for obtaining a high yield. In a comparison between seven maize genotypes during spring and fall planting times, Al-Khaz'ali *et al.* (2019) found that Bohoth106 significantly increased leaf area index, grain and biological yield for both planting times compared to other genotypes. While 5018 genotype had significant effect on harvest index, the study concludes that using a suitable maize genotype could lead to improve growth parameters which lead to increase grain yield. Leaf area index, grain and biological yield and harvest index were influenced significantly by maize hybrids (Kebede 2019). Whereas, Greveniotis *et al.* (2019) report no significant differences between commercial maize hybrids in kennels weight per ear and grain yield, while the correlation between them were significant and positive.

Planting time determination is essential to increase grain yield per unit area, which differs between the genotypes. Therefore, crop genotypes have a different response to planting time, and selecting the optimum one which suits the

Raheem, A.H., H.H.H.A. Kalee and A.A. Taha. 2023. The yield performance of maize (*Zea mays* L.) genotypes under different planting times. Journal of Global Innovations in Agricultural Sciences 11:657-664.
[Received 1 Aug 2023; Accepted 10OC 2023; Published 22 Dec 2023**]**

crop genotype is a key word for a successful crop management practices. This play a major role in determining the quantity and quality of maize yield (Bonea, 2020). Coelho *et al.* (2020) mentioned that planting time changes morphological and physiological attributes of maize, which can reflect on grain yield later. Differences in maize planting times affects the growth and yield. And this happen due to the difference temperature, solar radiation and humidity during crop growing season (Shrestha *et al.*, 2018). For that reason, determining maize planting time is a crucial element for production process and it is necessary to adapt with climate changes (Szeles and Huzsvai, 2020) which has a direct impact on crop planting time.

The optimal maize planting time differs by genotype, weather conditions and location. Many studies indicate to diverse planting times in Iraq according to the country's different regions, where Al-bdry (2019) investigated the effect of three planting times (15 July, 25 July and 4 August) on maize agronomic traits in Muthanna governorate southern Iraq. The author found that grain, biomass yield as well as harvest index were significantly increased by delaying planting time from 15 July to 4 August. Moreover, AL-Rawi and Al-Dulaimi (2021) found that planting maize at early July and early August record the same level of significance in grain yield (10.98 $t.ha^{-1}$),(10.81 $t.ha^{-1}$) respectively. While, planting at mid-July record the lowest average (9.24 $t.ha^{-1}$) the study carried out in rawa district located in western of Iraq. The results of another study which conducted in Tarmiah district-Baghdad central of Iraq, report that the best planting time for Bohoth106 genotype was on 21 July. Where it gave a highest grain yield (11.16 $t.ha^{-1}$) compared to other planting times (1, 10 and 28 July) (Ismail, 2021). On the other hand, Tabatabai *et al.* (2020) reported that delaying maize planting time caused a significant decrease in leaf area index (1.29 $t.ha^{-1}$), grain (1.8 $t.ha^{-1}$) and biological yield (8.1 $t.ha^{-1}$). Also, significant differences in maize grain yield due to genotype and planting times confirmed by Munarini and Nodari (2021). The aim of this study is to find out the yield parameters performance of maize genotypes under different planting times in Kirkuk district, Northern of Iraq.

MATERIALS AND METHODS

The study was carried out in Kirkuk district, Northern of Iraq located 35° 28′ N – 44° 19′ E, 331 m.s.l. The study conducted on a silt loam soil to investigate the yield performance of two maize (*Zea mays* L.) genotypes (Bohoth106 modern genotype vs. domestic maize genotype). The second factor include three planting times (early-July, mid-July and late-July), the experiment implemented by using randomized complete block design with three replicates. The plot size was 5×3.75m, distances between the ridges were 75cm while for the seedbeds were 25cm, 2-3 seeds were sown in each seedbed at 4-5cm depth manually on single side of the ridge. Seedlings per hole were reduced after a week from germination to maintain the number to 53333 $plants.ha^{-1}$. Irrigation process was carried out according to the weather conditions and plant requirements, also crop management practices such as fertilization, weed and pest control were carried out due to the recommendations (Guidance bulletin No. 18, 2006). Urea fertilizer (46 % N) was used as a source of nitrogen, while for phosphorus triple super phosphate fertilizer (46 % P_2O_5) had been added.

Data collection for studied traits were Leaf Area Index (LAI), Leaf Area Ratio (LAR) in a unit of measurement $cm^2.g^{-1}$: it is the ratio of the plant leaf area ($cm^2.plant^{-1}$) to plant dry weight ($g.plant^{-1}$) (Hunt, 1982), kernels $weight.ear^{-1}$(g), grain yield ($t.ha^{-1}$): which calculated by multiplying plant grain yield with plant density (Elsahookie, 1990), Stover yield ($t.ha^{-1}$), biomass yield ($t.ha^{-1}$), grain Stover ratio: it is the ratio of grain yield ($t.ha^{-1}$) to Stover yield ($t.ha^{-1}$) as a percentage, harvest index (%) and grain yield efficiency per plant ($mg.cm^2$): it is the ratio of the plant grain yield to the plant leaf area (Elsahookie, 2002).

Analysis of Variance (ANOVA) was used for data analysis and comparison between treatments were carried out by using Lest Significant differences (LSD) at probability level 0.05. The simple correlation coefficients analysis was done among all traits by using statistical analysis software version 9.0 (SAS-V9, 2002).

RESULTS AND DISCUSSION

Leaf Area Index (LAI):

Maize genotypes, planting times and their interaction had significant effects on leaf area index (Table 1). Where Bohoth106 record significant average of leaf area index 3.62 compared to domestic maize 2.86. This occurred due to increase in Bohoth106 plant leaves number, leaf area and leaf breadth. The results are in agreement with Al-Khaz'ali *et al.* (2019) finding that Bohoth106 significantly increased LAI compared to other genotypes. Kebede (2019) Conclude variety had a significant effect on maize leaf area index, also Rahouma (2021) report that maize hybrids record significant difference in LAI after 95 days of sowing.

Delaying the planting time caused a significant increase in LAI, a highest average was at mid-July 3.60 which did not differed significantly with late-July 3.34. Whereas the lowest was for early-July 2.78. The reason behind this attribute links to the high average in leaf area index at mid and late-July planting times. In addition, temperature reduction by delaying planting time from early-July to late-July lead to increase dry matter accumulation. This could be used in plant growth instead of respiration operation. On the other hand high temperature at early-July led to plant height reduction by decreasing inter node length which lead to decrease in leaf number, leaf area and leaf area index (Shrestha *et al.*, 2018).

Interaction between Bohoth106 and mid-July gave a highest amount of LAI 3.89, whereas domestic maize with early-July gave the lowest amount of LAI 1.93. The reason for this was may be due to significant interaction between Bohoth106 with mid-July in the number of leaves and leaf area.

Table 1. Effect of genotype and planting time on maize leaf are index.

Genotype (G)		G × P		
Bohoth106 (G1)	3.62	G1	P1	3.64
Domestic Maize (G2)	2.86		P2	3.89
LSD (P= 0.05)	0.32		P3	3.35
Planting time (P)		G2	P1	1.93
Early-July (P1)	2.78		P2	3.32
Mid-July (P2)	3.60		P3	3.32
Late-July (P3)	3.34	LSD (P= 0.05)		0.56
LSD (P= 0.05)	0.40	CV %		9.50

***Leaf Area Ratio (LAR)*: ** The effects of Maize genotypes and planting times on leaf area ratio are presented (Table 2). Bohoth106 had significant influence on leaf area ratio 17.6 $cm^2.g^{-1}$, compared to domestic maize 13.1 $cm^2.g^{-1}$. This may be attributes to high value of Bohoth106 in leaf area index, where a positive and highly significant ($p = 0.01$) correlation were be found between LAI and LAR ($r = 0.796$) (Table 10). Leaf area ratio significantly and linearly increased with delaying planting time from early-July to late-July 13.8, 15.0 and 17.3 $cm^2.g^{-1}$ respectively (Table 2). This may be due to an increasing in leaf area and LAI, where LAR correlated positively and significantly with LAI (Table 10).

Growing Bohoth106 at early and late July gave a highest mean of LAR 18.6 and 18.9 $cm^2.g^{-1}$ respectively, whereas domestic maize genotype at early-July had the lowest mean of LAR 9.1$cm^2.g^{-1}$.

Table 2. Effect of genotype and planting time on maize leaf area ratio ($cm^2.g^{-1}$).

Genotype (G)		G × P		
Bohoth106 (G1)	17.6	G1	P1	18.6
Domestic Maize (G2)	13.1		P2	15.5
LSD (P= 0.05)	0.9		P3	18.9
Planting time (P)		G2	P1	9.1
Early-July (P1)	13.8		P2	14.5
Mid-July (P2)	15.0		P3	15.7
Late-July (P3)	17.3	LSD (P= 0.05)		1.6
LSD (P= 0.05)	1.1	CV %		5.66

***Kernels weight.ear^{-1}*: ** Maize kernels weight.ear^{-1} affected significantly by genotype and planting time (Table 3), where the highest average was obtained by Bohoth106 151.0 g but the lowest value was for 127.7 g. These results might be attributed to the high records of Bohoth106 in LAI and LAR, also kernels weight.ear^{-1} positively and significantly (p = 0.01) correlated with LAI ($r = 0.842$) and LAR ($r = 0.692$) respectively (Table 10). The results agreed with AL-Dawdi and AL-Jobouri (2015) and Sab *et al.* (2020) who found a significant effect of maize genotypes on kernels weight.ear^{-1}. Kernels weight.ear^{-1} increased significantly by delaying planting time from early-July (114.4 g) to mid-July (160.2 g), while it decreased at late-July (143.6 g). The reason for high kernels weight.ear^{-1}at mid-July attributes to LAI (Table 1). Where a positive and highly significant ($p = 0.01$) correlation were observed between kernels weight.ear^{-1} and LAI (Table 10). The results are in agreement with Sab *et al.* (2020) that maize kernels weight.ear^{-1}significantly affected by planting times, where it increased significantly for planting at mid-July compared to late-July.

Planted Bohoth106 mid-July gave a highest mean of kernels weight.ear^{-1} 164.5 g, while it was the lowest for domestic maize at early-July 87.6 g. This might be linked to the significant interaction between Bohoth106 and planting at mid-July in LAI (Table 1), where a positive and highly significant correlation were found between kernels weight.ear^{-1} and LAI (Table 10).

Table 3. Effect of genotype and planting time on maize kernels weight.ear^{-1}(g).s

Genotype (G)		G × P		
Bohoth106 (G1)	151.0	G1	P1	141.2
Domestic Maize (G2)	127.7		P2	164.5
LSD (P= 0.05)	3.3		P3	147.4
Planting time (P)		G2	P1	87.6
Early-July (P1)	114.4		P2	155.8
Mid-July (P2)	160.2		P3	139.7
Late-July (P3)	143.6	LSD (P= 0.05)		5.7
LSD (P= 0.05)	4.1	CV %		2.26

***Grain yield*: ** A significant effect of genotype and planting time were found on maize grain yield (Table 4). Bohoth106 significantly increased grain yield 10.4 $t.ha^{-1}$, whereas domestic maize had the lowest value 8.1 $t.ha^{-1}$. This happened due to the high record for Bohoth106 in LAI, kernels weight.ear^{-1}, Stover yield (Table 1, 3 and 5) and yield components. The significant and positive correlation found between grain yield with LAI ($r = 0.555$) and Stover yield ($r = 0.566$) (Table 10). The previous results are similar with Mamudu and Adedokun (2019) where they found that, maize modern varieties sisgnificantly increased grain yield compared to domestic maize, Fromme *et al*. (2019), Erawati (2020);Hussein and Ahmed (2023) found that maize genotypes had significant impact on grain yield.

Grain yield increased significantly by delaying planting time from early-July (8.7 $t.ha^{-1}$) to mid-July (10.0 $t.ha^{-1}$) and it decreased again (not significantly) at late-July (9.1 $t.ha^{-1}$). This results are identical to LAI results (Table 1) where this tow traits (grain yield and LAI) correlated positively and significantly (Table 10), Also mid-July record significant

amount in kernels weight.ear^{-1} (Table 3) this shows that mid-July could be a suitable for sowing maize at study area to achieve high grain yield. The results are in agreement with Ali *et al.* (2018) who report that maize grain yield significantly affected by planting time also Sab *et al.* (2020) noticed that grain yield for planted maize at mid-July was significantly higher than late-July. Moreover, Ismail (2021) obtained highest grain yield for Bohoth106 which cultivated at 21st of July in Tarmiya district, Baghdad central of Iraq.

Planted Bohoth106 at mid-July had significant record for grain yield 11.2 t.ha^{-1}, whereas the lowest value was for domestic maize at early-July 7.7 t.ha^{-1}. These results are agreed with Gurung *et al*. (2018) and Ateeq, *et al*. (2020) finding, that interaction between variety and planting time had significant influence on maize grain yield.

Table 4. Effect of genotype and planting time on maize grain yield (t.ha^{-1}).

Genotype (G)		G × P		
Bohoth106 (G1)	10.4	G1	P1	9.6
Domestic Maize (G2)	8.1		P2	11.2
LSD (P= 0.05)	1.0		P3	10.3
Planting time (P)		G2	P1	7.7
Early July (P1)	8.7		P2	8.8
Mid July (P2)	10.0		P3	7.9
Late July (P3)	9.1	LSD (P= 0.05)		1.5
LSD (P= 0.05)	1.1	CV %		9.41

Regression analysis between grain yield and other traits in this study for interaction between the genotypes and planting times showed a simple curvilinear regression relationship was the most appropriate description for the relationship between maize grain yield with all studied traits according to determination coefficient values except with biomass yield where the simple regression relationship was the most suitable to description the relationship between maize grain yield and biomass yield (Figure 1: A-F). Simple polynomial regression model indicate that, grain yield under interaction between genotype and planting time determined by: leaf area index influenced grain yield (R^2 = 0.693), kernel weight.ear^{-1} (R^2 = 0.593) and grain yield efficiency per plant (R^2 = 0.855) by a quadratic equation (Figures A, B and F), respectively. Stover yield influenced grain yield which determined by the cubic equation (R^2 = 0.621) also harvest index influenced grain yield where it determined by the quartic equation (R^2 = 0.556) (figures C and E), respectively. On the other hand, the simple linear regression model found the relation between grain yield and biomass yield and their influence on grain yield (R^2 = 0.714) by linear equation (Figure D). Diagram for regression relationship between grain yield with leaf area ratio and grain Stover ratio did not showed because that up to a quintic equation which did not data goodness of fit and the determination coefficient value did not attainted to 50 % , so they were neglected.

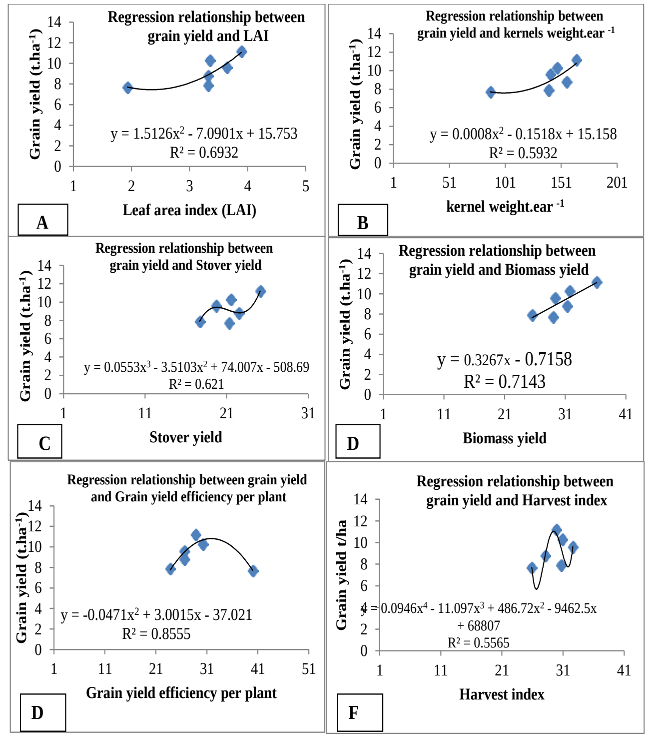

Figure 1. Regression relationship between grain yield and leaf area index (A), kernel weight.ear^{-1} (B), Stover yield (C), biomass yield (D), harvest index (E) and grain yield efficiency per plant (F).

***Stover yield*:** The results of genotype and planting time on Stover yield are shown (Table 5). Similarly to previous traits Bohoth106 significantly gave the highest average in Stover yield 22.1t.ha^{-1}. Whereas domestic genotype had the lowest 20.5 t.ha^{-1}, this happen due to significant performance of Bohoth106 in biomass yield (Table 6). A positive and highly significant (p = 0.01) correlation were found between Stover yield and biomass yield (r = 0.905) (Table 10). Similar findings were also stated by Hasan *et al.* (2018) where they obtained significant differences in Stover yield for maize varieties.

Maize Stover yield significantly increased when it planted at mid-July 23.8 t.ha^{-1} compared to early and late-July 20.5 and 19.6 t.ha^{-1} respectively. These results are similar to biomass yield outcomes (Table 6) because there is a positive and highly significant (p = 0.01) correlation between them (Table 10). This result is in context to Seb *et al.* (2020) finding, where the planting at mid-July gave a highest average in Stover yield compared to late-July. Interaction between Bohoth106 and mid-July gave the highest Stover yield 25.1t.ha^{-1}, whereas domestic maize and late-July had the lowest 17.7 t.ha^{-1}. These results showing a clear relation between biomass yield and Stover yield (Table 6 and 10).

Table 5. Effect of genotype and planting time on maize Stover yield ($t.ha^{-1}$).

Genotype (G)		**G × P**		
Bohoth106 (G1)	22.1	G1	P1	19.7
Domestic Maize (G2)	20.5		P2	25.1
LSD (P= 0.05)	1.4		P3	21.5
Planting time (P)		G2	P1	21.3
Early July (P1)	20.5		P2	22.5
Mid July (P2)	23.8		P3	17.7
Late July (P3)	19.6	LSD (P= 0.05)		2.5
LSD (P= 0.05)	1.7	CV %		6.36

***Biomass yield*: ** Biomass yield was significantly increased for Bohoth106 32.4 $t.ha^{-1}$ compared to domestic genotype 28.6 $t.ha^{-1}$. Also significant differences were observed in biomass yield in terms of planting times, where it was significantly higher 33.8 $t.ha^{-1}$ for mid-July compared to early and late July 29.2 and 28.6 respectively.

A significant interaction was observed for biomass yield between Bohoth106 and mid-July 36.2 $t.ha^{-1}$ while the lowest was for domestic genotype and late-July 25.5 $t.ha^{-1}$. The significant influence for Bohoth106 and mid-July in biomass yield were as a reflection for their records in grain yield and Stover yield (Table 4 and 5). As well a positive and highly significant ($p = 0.01$) correlation between biomass yield with grain yield ($r = 0.789$) and Stover yield ($r = 905$) (Table 10). The results agreed with Ali *et al.* (2018) that report maize biomass yield significantly affected by variety and planting time, also Al-Khaz'ali *et al.* (2019) found that Bohoth106 record significant value in biomass yield compared to other genotypes during spring and fall planting times.

Table 6. Effect of genotype and planting time on maize biomass yield ($t.ha^{-1}$).

Genotype (G)		**G × P**		
Bohoth106 (G1)	32.4	G1	P1	29.3
Domestic Maize (G2)	8.6		P2	36.2
LSD (P= 0.05)	1.7		P3	31.7
Planting time (P)		G2	P1	29.0
Early July (P1)	29.2		P2	31.3
Mid July (P2)	33.8		P3	25.5
Late July (P3)	28.6	LSD (P= 0.05)		2.9
LSD (P= 0.05)	2.1	CV %		5.24

***Grain Stover Ratio*: ** Bohoth106 significantly increased grain Stover ratio 46.8 %, compared to domestic genotype 39.8 % (Table 7). This may be attributes to effect of the increasing in LAI, LAR and grain yield for Bohoth106 which reflected grain Stover ratio positively. Where there was a positive and highly significant ($p = 0.01$) correlation between grain Stover ratio with LAI ($r = 0.665$) and LAR ($r = 0.765$), which correlated positively and significantly ($p = 0.05$) with grain yield ($r = 0.566$). This correlation related negatively and non-significantly with Stover yield (Table 10). These findings are in context with Dawadi and Sah (2012) where they noticed a significant difference between two maize varieties in grain Stover ratio trait.

Late-July had the significant effect on grain Stover ratio 45.8 %, while mid-July gave the lowest average 41.6 %. The reason behind that could linked with significant increase in LAI and LAR for Late-July (Table 1 and 2) while it record the lowest average in Stover yield (Table 5). All previous results led to significant increase for late-July in grain Stover ratio. Which confirms this interpretation is a positive and a significant correlation between grain Stover ratio with LAI, LAR and grain yield, and the reason of a lowest average in grain Stover ratio for mid-July planting time due to an increase in average of Stover yield (Table 5) which has a negative correlation relationship with grain Stover ratio (Table 10).

Bohoth106 and early-July gave a significant mean of grain Stover ratio 49.4 %, whereas domestic maize with early-July gave the lowest mean of grain Stover ratio 35.8 %. This result shows that effect of genotype was stronger than planting time on grain Stover ratio trait, where the same planting time records a highest and lowest grain Stover ratio with both genotypes. In general the trait has a positive and significant correlation with grain yield which cause an increase in grain Stover ratio for Bohoth106, while the negative correlation relationship with Stover yield caused a decrease in average of grain Stover ratio for mid-July and for the interaction between Bohoth106 and mid-July.

Table 7. Effect of genotype and planting time on maize grain Stover ratio (%).

Genotype (G)		**G × P**		
Bohoth106 (G1)	46.8	G1	P1	49.4
Domestic Maize (G2)	39.8		P2	44.1
LSD (P= 0.05)	2.8		P3	47.0
Planting time (P)		G2	P1	35.8
Early July (P1)	42.6		P2	39.1
Mid July (P2)	41.6		P3	44.5
Late July (P3)	45.8	LSD (P= 0.05)		4.8
LSD (P= 0.05)	3.4	CV %		6.10

***Harvest index*: ** Harvest index influenced significantly by maize genotype, where Bohoth106 significantly increased by 31.1 % compared to domestic maize 28.2 % (Table 8). This indicated that Bohoth106 was more efficient than domestic maize in changing total dry matter into economic yield. Also this happen as result of an increase in LAI, LAR, kernels $weight.ear^{-1}$, grain yield and grain Stover ratio (Table 1, 2, 3, 4 and 7). In addition, a positive and significant correlation were found between harvest index and LAI ($p = 0.05$; $r = 0.580$), LAR ($p = 0.01$; $r = 0.739$), kernels $weight.ear^{-1}$($p = 0.05$; $r = 0.466$), grain yield ($p = 0.05$; $r = 0.530$) and grain stover ratio ($p = 0.01$; $r = 0.918$) (Table 10). The results are

agreement with AL-Niemi, et al. (2014); Al-Khaz'ali et al. (2019) and Kebede (2019) who indicated that maize genotypes had a significant impact on harvest index. However, planting time did not showed a significant influence on harvest index.

Interaction between Bohoth106 and early-July planting time gave a significant harvest index 32.6 %, whereas domestic maize with early-July had the lowest 25.9 %. This result is similar to LAI, LAR and grain Stover ratio results (Table 1, 2 and 7). Where harvest index correlated positively and significantly ($p = 0.01$) with LAR and grain Stover ratio while correlated positively and significantly ($p = 0.05$) with LAI (Table 10). Moreover, these results indicated that impact of genotype was more visual than planting time on harvest index in this study.

Table 8. Effect of genotype and planting time on maize harvest index (%).

Genotype (G)		G × P		
Bohoth106 (G1)	31.1	G1	P1	32.6
Domestic Maize (G2)	28.2		P2	29.9
LSD (P= 0.05)	1.7		P3	30.9
Planting time (P)		G2	P1	25.9
Early July (P1)	29.3		P2	28.1
Mid July (P2)	29.0		P3	30.7
Late July (P3)	30.8	LSD (P= 0.05)		2.9
LSD (P= 0.05)	N.S	CV %		5.37

***Grain yield efficiency per plant*:** Maize genotypes did not showed a significant effect on grain yield efficiency per plant, while planting time impacted the studied trait significantly (Table 9). Early-July obtained a significant average in grain yield efficiency per plant 33.4 $mg.cm^{-2}$, whereas mid and late-July had the lowest average 27.7 and 27.0 $mg.cm^{-2}$, respectively. This trait indicates to plant grain yield by mg (or g) for each cm^2 of plant leaf area, so it can be noticed from the obtained data that, increasing in total plant leaf area lead to a decrease in grain yield efficiency per plant and vice versa. This may be due to leaves shading especially lower leaves. Pervious results confirmed by negative and high significant ($p = 0.01$) correlation between grain yield efficiency per plant with LAI ($r = -0.760$) and LAR ($r = -0.888$), kernels $weight.ear^{-1}$ ($r = -0.867$). While it correlated negatively and significantly ($p = 0.05$) with grain Stover ratio ($r = -0.520$) and harvest index ($r = -0.583$) (Table 10).

Planted domestic maize at early-July increased grain yield efficiency per plant significantly 40.0 $mg.cm^{-2}$, whereas domestic maize and late-July had the lowest 23.8 $mg.cm^{-2}$.This means that impact of planting time had greater impact than genotype on grain yield efficiency per plant. The reason of significant increase of domestic maize in grain yield efficiency per plant at early-July may be due to low mean in LAI, LAR, kernels $weight.ear^{-1}$, grain Stover ratio and harvest index. Where there was a negative and significant correlation with grain yield efficiency per plant (Table 10). Moreover, less value in LAI resulting less mutual shading effect for number of leaves might be a reason to enhance the efficiency of plant leaf area (cm^2) in grain yield production (mg).

Table 9. Effect of genotype and planting time on maize grain yield efficiency per plant ($mg.cm^{-2}$).

Genotype (G)		G × P		
Bohoth106 (G1)	28.5	G1	P1	26.6
Domestic Maize (G2)	30.1		P2	28.8
LSD (P= 0.05)	N.S		P3	30.2
Planting time (P)		G2	P1	40.0
Early July (P1)	33.4		P2	26.6
Mid July (P2)	27.7		P3	23.8
Late July (P3)	30.8	LSD (P= 0.05)		2.9
LSD (P= 0.05)	N.S	CV %		5.37

***Conclusion*:** The previous results revealed that maize different genotypes had a significant effect on all studied parameters except grain yield efficiency per plant. The study outcomes showed that modern maize genotype (Bohoth106) performed better than domestic maize in terms of effectiveness utilization of growth factors such as light, moisture and nutrients which reflected positively in high photosynthesis activity and thereby high transferring of photosynthetic into grain yield. Also the results observe that

Table 10. Pearson correlation coefficients among maize studied traits.

	Leaf area index	Leaf area ratio	Kernel weight	Grain yield	Stover yield	Biomass yield	Grain stover ratio	Harvest index
Leaf area ratio	0.796^{**}							
Kernel $weight.ear^{-1}$	0.842^{**}	0.692^{**}						
Grain yield	0.555^{*}	$0.207^{n.s}$	$0.430^{n.s}$					
Stover yield	$0.135^{n.s}$	$-0.433^{n.s}$	$0.151^{n.s}$	0.570^{*}				
Biomass yield	$0.348^{n.s}$	$-0.201^{n.s}$	$0.279^{n.s}$	0.789^{**}	0.905^{**}			
Grain Stover ratio	0.665^{**}	0.765^{**}	$0.426^{n.s}$	0.566^{*}	$-0.211^{n.s}$	$0.108^{n.s}$		
Harvest index	0.580^{*}	0.739^{**}	0.466^{*}	0.530^{*}	$-0.216^{n.s}$	$0.045^{n.s}$	0.918^{**}	
Grain Yield Efficiency	-0.760^{**}	-0.888^{**}	-0.867^{**}	$-0.143^{n.s}$	0.266	$0.136^{n.s}$	-0.520^{*}	-0.583^{*}

n.s: no significant, *: significant at probability 0.05 and **: significant at probability 0.01.

mid-July produced greater yields (grain, Stover and biomass) compared to early and late-July, where the lowest yields were obtained from early-July, where maize plants suffered from high temperature and low humidity especially during flowering stage thus reduced plant growth which lead to lower yield. Based on the study result, it could be conclude that optimum planting time for Bohoth106 in the study region was at mid-July, where it gave a significant grain and Stover yield. Also it could be delayed to late-July when it's necessary, where it did not affect grain yield significantly. Therefore, the study advice the farmers in Kirkuk district by sowing Bohoth106 at mid-July till late-July to achieve high grain yield. Numerous significant and positive correlations were found between grain yield and LAI, Stover yield, biomass yield, grain Stover ratio and harvest index. These relations show the positive effect of those traits which lead to enhance grain yield.

Author's contributions: All the authors contributed to the manuscript writing and publication the paper.

***Conflict of interest*:**The authors declare that there is no conflict of interest.

Acknowledgement:authors are thankful for Kirkuk University for supports.

***Ethical statement*:** considered based on regulation of Kirkuk University ethical committee.

Availability of data and material: all data will be available when journal has request.

Code availability: Not applicable.

Consent for publication: The authors agree to publish this paper.

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